PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

PLANTERS' BULLETIN FORTY-THREE

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R R I

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EXPERIMENT STATION AND FACTORY. This station of the R R I is situated 16 miles from Kuala Lumpur, at Sungei Buloh on the Kuala Lumpur — Kepong — Kuala Selangor road. Visits may be made on Mondays or Wednesdays by arrangement. There is a guest house.

CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special inquiries may be marked for the attention of particular officers. The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 72051. PARCELS occasionally arrive without any indication of their origin. Senders' names and addresses should be written clearly on the outside of all packages, and advice of despatch should be given by letter or telegram.

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ADVICE. Inquiries are invited from rubber producers in the Federation of Malaya, the Colonies of Singapore and North Borneo, and the territories of Sarawak, Brunei and Nigeria, who may require more detailed information applicable to their own special problems. Where it is considered necessary, visits will be made to estates in Malaya as convenient. Visits to estates in other territories are by special arrangement. The only visits for which charges are normally made are those of our clone indentification inspectors. INTERVIEWS should be arranged by letter, as members of the senior research and advisory staff are frequently absent on visits to plantations.

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OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur July 1959 Number 43

Editorial: From 'Synthetic' to 'Synthetic Natural'

Although synthetic materials with rubberlike properties have been known for almost half a century, the large scale production of a general purpose synthetic rubber was essentially an outcome of the 1939 – 1945 war. Although these synthetic materials have been absorbed by rapidly expanding world markets, they have nevertheless had some impact on the price of natural rubber – one of the few natural commodities still selling at little above 1940 prices.

Until about five years ago these man-made materials were very different from natural rubber chemically, although resembling it closely in some of its more important physical properties. Special purpose synthetic materials, for example acrylonitrile copolymers, Neoprene, Hypalon, silicones and butyl rubbers, give better service than natural rubber in certain applications which demand specific properties: these include impermeability to air and resistance to the adverse effects of contact with oil, exposure to the atmosphere and subjection to extremes of temperature. At the same time it is now generally accepted that the general purpose synthetic rubber SBR (formerly known as GRS) gives improved tyre wear in warm climates compared with the natural product – the tyre industry, it should be noted, is still the major consumer of rubber. Most of these synthetic materials are derived from by-products of the petroleum industry and more particularly from butadiene which is cheap and plentiful. Many of the synthetic rubber factories recently constructed in Europe will be making rubbers of these types, including SBR.

SBR is initially produced as a latex which can either be concentrated for industrial use or processed to give dry rubber. As concentrated latex, SBR is deficient in wet gel strength, and it is therefore usual to blend it with natural latex for the production of foam rubber, the proportions depending mainly on the price difference between the two materials. When processed to give dry rubber, SBR reaches the consumer's factory in attractively wrapped small bales which are easily handled on fork-lift trucks. Recently one large manufacturer has introduced SBR in the form of a coarse crumb particularly well suited to the needs of factories using automation. It should be noted that the full impact of automation on manufacturers' raw rubber requirements has yet to be ascertained.

Despite these advances in synthetic rubber production, the overall superiority of natural rubber was never seriously challenged until a few years ago. Rubber chemists then succeeded for the first time in producing a rubber (cis-polyisoprene) which is *virtually identical, both chemically and structurally,* with natural rubber. Furthermore its technical properties approximate to those of the natural product; this is achieved by the incorporation of certain non-rubber substances which correspond with those occurring naturally in tree rubber.

The raw material for the new 'synthetic natural' rubbers is isoprene, again a by-product of the petroleum industry. It the past, Isoprene has been expensive and little used, but production at a satisfactory price in response to expanded demand may well be possible in view of the flexibility of modern refining processes. According to announcements made about three months ago production of the finished synthetic rubber at a price in the region of 90 cents (Malayan) is claimed to be commercially feasible. The successful pilot-plant production of this new synthetic polyisoprene rubber has been made known to the public by four of the larger American rubber companies during the last three years. Thus Firestone announced their 'Coral' rubber, Goodrich-Gulf their 'Ameripol SN' and Goodyear Tyre and Rubber their 'Natsyn'; now the U.S. Rubber—Shell group have announced their large scale commercial production of cis-polyisoprene without, however, indicating a trade name or the anticipated output. All these have been referred to in the press as 'synthetic natural' rubbers. Technical journals have also indicated that the Soviet Union is now producing substantial quantities of polyisoprene synthetic rubber by a new process.

Clearly, the cost of commercial production of cis-polyisoprene rubber must be related to the cost at which isoprene of the necessary degree of purity can be obtained. From what is known about the manufacturing processes involved in making the new rubber, the indicated price of 90 cents (Malayan) does not appear to be unreasonable. At this figure natural rubber has little to fear in open competition. It remains to be seen whether increasing use of the new synthetic rubber by manufacturers will lead to a demand for greater standardisation of the quality and presentation of the natural product.

Disposal of Skim Serum

SKIM SERUM, AN UNWANTED BY-PRODUCT of latex concentrate production, is normally disposed of in the nearest stream. This procedure not only tends to aggravate stream pollution but also represents a direct loss to the land of valuable plant nutrients. A method of using the serum as a fertiliser, already practiced on a few estates, is described below.

Undiluted skim serum from the coagulating tank varies a little in composition, but usually contains about 4% total solids, including 0.26%

ammoniacal nitrogen in the form of ammonium sulphate, 0.09% protein nitrogen, and some 0.2% potassium. This makes skim serum a useful, if somewhat unbalanced, fertiliser which can be used as a source of both nitrogen and potassium for rubber trees. It is possible to dispose of a factory's entire output of skim serum over an area forming 7% or less of the estate and to eliminate the need in that area for separate applications of ammonium sulphate and muriate of potash.

Skim serum may be applied to the soil either by hand or by using a trailer tank with an outlet valve at the bottom; the valve is partly opened so that the liquid flows out as the tank is towed along a line of trees. The latter method requires a reasonably flat and accessible area with room to manoeuvre a tractor. Improved distribution of the liquid will be obtained if a spraying boom is fitted to the outlet valve. An iron pipe 6 ft long and 1 in. in diameter, with about five $\frac{1}{4}$ in. or $\frac{3}{8}$ in. holes spaced along its length, is suitable. Before filling the tank, residual coagulum should be removed from the serum to avoid blockages of the distributing equipment.

No great difficulties are involved in using skim serum as a fertiliser. Sulphuric acid remaining in the skim serum is not sufficiently concentrated to have a marked effect on soil acidity. Spraying serum on the bark of the trees should of course be avoided as far as possible.

The recommended rate of application of skim serum will vary within narrow limits depending on the concentration of the plant nutrients it contains. Applications of skim serum at the rate of 6 or 7 gallons per tree three times a year are usually recommended, supplemented by separate applications of rock phosphate at the rate of $1\frac{1}{2}$ lb per tree once every two years. These quantities are for mature rubber and smaller amounts should be given to young trees.

Information from present users of the process indicates that the cost of applying 450-650 gallons to one acre is around 4 to 5 dollars (Malayan). In 450 gallons of serum the value of the ammonium sulphate content alone is a little over 6 dollars, so that applying the serum in this way appears to be cheaper than buying ammonium sulphate fertiliser. It must be emphasized that the skim serum should be diluted as little as possible. If washings are allowed to dilute the serum, distribution costs will be higher.

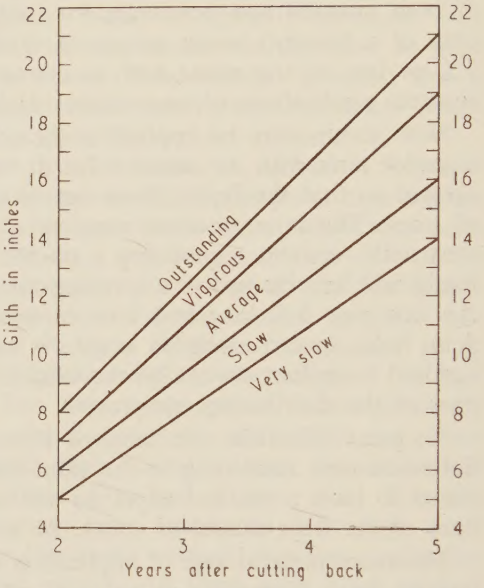
The above estimates of cost apply to areas within two or three miles of the skim rubber plants. The method described here becomes increasingly uneconomic as the serum is transported over greater distances: it will certainly not be practicable for concentrate manufacturers who obtain all their supplies of latex from estates in outlying districts.

Readers who intend to start using skim serum as a fertiliser are advised to send samples of their skim serum to the Rubber Research Institute for analysis, so that specific advice regarding the rate of application can be given.

Assessment of the Growth of Clone RRIM 501

GIRTH MEASUREMENTS PROVIDE a ready means of following the growth of rubber trees, but in order to assess these measurements in terms of relatively vigorous or poor development, a standard of normal growth is required. With this object in view we have calculated the mean girth of buddings of clone RRIM 501 at 2, 4 and 5 years after budding in all post-war clone trials conducted on estates. RRIM 501 has been the control in all these trials, and consequently provides an extensive series of records.

The stand at planting in these trials was 180 points or more per acre. Subsequently,



Classification of girth measurements 60 in. above the union, in terms of vigour.

MEAN GIRTH OF CLONE RRIM 501 AND CLASSIFICATION OF GIRTHS IN TERMS OF VIGOUR

	Girth measurements		
Years after budding	2	4	5
Number of trials	55	43	43
Mean girth in inches (60 inches above the union) for all trials	6.5	13.8	17.2
	Classification of girths in inches		
Very slow	below 5	below 11	below 14
Slow	5–6	11–13	14–16
Average	6–7	13–15	16–19
Vigorous	7–8	15–17	19–21
Outstanding	over 8	over 17	over 21

following normal practice, the stand was thinned to 145 trees per acre by the fifth year after budding. (It should be borne in mind that the degree of thinning, and thus the proportion of well developed trees remaining at the time of measurement, has an effect on average girth). Girths were measured at 60 inches from the union.

The results are tentatively classified in the Table. This classification is also expressed diagramatically to help planters to evaluate girth measurements taken at ages differing from those in our Table. It may be used to appraise the growth of RRIM 501 and also clones of similar average vigour.

Wind Damage

THE DESTRUCTION OF TREES by storms is one of the most frustrating forms of loss. The damage is often beyond repair and occurs at a stage in the life of the stand when replacement is uneconomic. We do not know the incidence of wind damage over the whole country but if advisory correspondence devoted to this subject is any guide both the frequency and severity of wind damage are increasing. This may be caused by the employment of high yielding clones which have shown unexpected wind susceptibility and by the increased use of fertilisers.

We have examined many areas where damage has occurred and endeavoured to classify the forms it has taken. We have suggested theories to account for the damage particularly in material hitherto considered wind resistant. On the basis of these theories we suggest various means which may reduce or prevent severe losses. However, it should be understood that we have not yet had opportunity to test all these suggestions fully; they are tentative recommendations.

Catastrophic loss of entire replantings has occurred in a few instances and heavier damage than anticipated has been widespread. We give this early notice of our views because this situation may deteriorate further and because certain of the measures suggested need to be applied early in the life of the trees. Current practices may require long term revision.

THE INCIDENCE OF WIND IN MALAYA

Malaya lies outside the portion of the tropics where severe storms are frequent. In general wind velocities are quite low. During ten year periods, gusts of wind exceeding 40 m.p.h. (gale force) were recorded on 3 days at Sitiawan and on 146 days at Malacca – these were the Malayan extremes; the corresponding figures for the British Isles are over 190 for east England and over 450 for north west Ireland. A gust at 70 m.p.h. once swept Ipoh and was considered remarkable for Malaya. The maximum wind speed ever recorded in the world (summit Costa Hill, Orkney) is 127 m.p.h.

A general impression of the incidence of surface wind speeds in Malaya may be gathered from *Figure 1*. This diagram is compiled from data we have extracted from *Malayan Meteorological Service, Climatological Summaries, Part I. Wind*, for the use of which we are indebted to the Director of the Service. Incomplete records for Ipoh and Butterworth indicate that the figures given here for the relatively sheltered locations of Sitiawan and Bayan Lepas are not entirely typical of the area — the Perak coast cannot be assumed to be storm free.

Allowing for such vagaries due to the immediate location of the stations, we can make the following generalisations on wind in Malaya. Windiness, as judged by mean wind velocity or the incidence of strong gusts, tends to increase with proximity to the coast and with elevation. Thus lowland districts inland appear to be relatively calm. The greater part of the East Coast as far north as Kuala Trengganu appears to be very windy and the same seems to be true of the West Coast from Singapore up to Bukit Jeram at least.

Rubber is not grown uniformly over Malaya and the incidence of wind damage reported must be evaluated in the light of the distribution of rubber plantations. As far as the principal rubber growing areas are concerned, most wind damage appears to have been sustained along the coasts of Malacca, Negri Sembilan and Selangor — the strip between Malacca and Bukit Jeram.

This outline of the incidence of wind in Malaya helps to explain why wind damage has been more severe in some districts and indicates where special precautions should be taken. Yet nowhere can be considered immune. Often local features such as funnel-shaped valleys

Explanation of Figure 1

Each station is indicated by a circle, the centre marking the location, and the diameter is proportional to the estimated mean wind velocity over ten years.

The histograms show the percentages of the ten year period during which the wind blew at each force on the Beaufort scale. A cross (+) indicates a percentage less than 0.1.

	Beaufort Scale						
Beaufort no.	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Velocity m.p.h.	*calm*	*1-3*	*4-7*	*8-12*	*13-18*	*19-24*	*25-31*

The three figures below the station name are respectively:
the height in feet above mean sea level
the number of days in ten years when gusts of more than 40 m.p.h. were recorded
the number of days in ten years when gusts of more than 30 m.p.h. were recorded

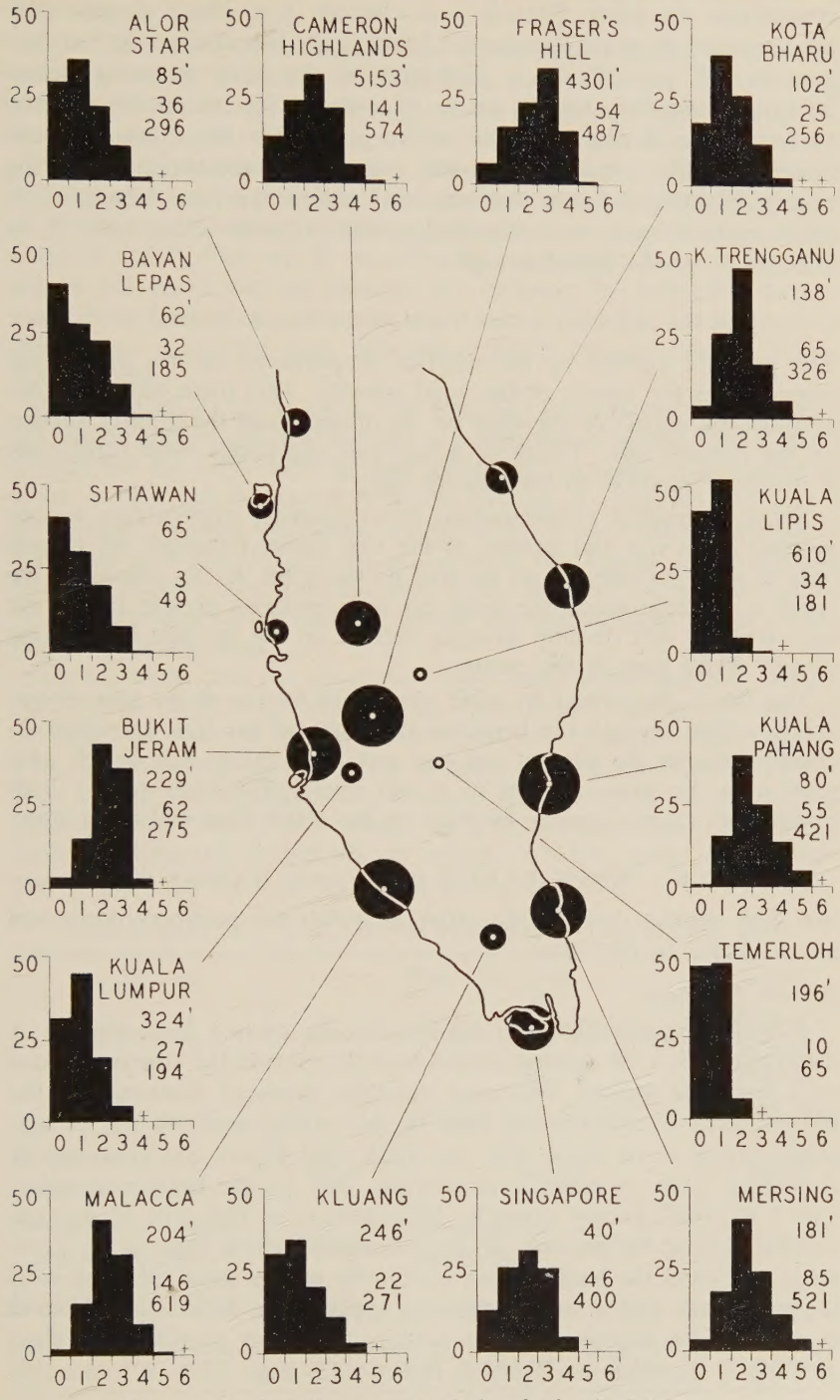


Figure 1. Distribution of wind velocity in Malaya.

concentrate the wind. Even if it is assumed that winds of gale force are necessary to cause damage (and these may be expected on ten days over the 35 year life of a replanting at the most sheltered station Sitiawan) there may still be ample opportunity for susceptible material to be smitten during the peak of its productive life. Trees may be rendered highly susceptible to trunk snap by a combination of tapping history, planting distance and manurial policy; we have seen trees in this condition break when the breeze was probably about force 3, or possibly 4, on the Beaufort scale.

THE ACTION OF THE WIND ON A TREE

The pressure exerted by the wind is proportional to the size of the obstacle and the square of the wind velocity. This force has two components, the impact of the wind on the obstacle and the drag or suction on the leeward side. Therefore a tree will experience wind force even if it is only exposed on the leeward side.

These theoretical considerations have practical applications to our problem. The size and density of the tree crown influence the magnitude of the force exerted on the tree by the wind. If the canopy of the stand is not continuous the wind not only makes a greater impact on each tree but will develop stronger suction on the lee side by drawing air out of the gaps in the canopy.

The force, determined by wind speed and nature of the tree crown, is transmitted through the branches and trunk of the tree. Leverage increases towards the base of the tree and the weakest member in proportion to the stress applied to it will break. Tall trees with a high canopy will exert a greater leverage on the trunk than will squat trees.

THE MAIN TYPES OF WIND DAMAGE

We shall discuss these in the order in which the members concerned are subjected to the stress.

Branch Breakage

A branch may break off at the fork tearing away a large portion of the trunk with it. If damage of this sort is repeated the tree is reduced to a worthless stump. The most common cause of weakness in the branch forks is inclusion of bark in the crotch owing to the branch arising at an acute angle with the trunk (See *Figure 3*). This sort of damage is often a clonal characteristic due to the branching habit; Tjir 1 is a well known example. Susceptibility to this type of damage can be reduced by pruning off large branches which arise at an acute angle and rival the leader. They should be cut or sawn off flush with the main stem and a wound dressing applied if a large area of wood is exposed. An asphalt kerosene mixture or similar proprietary wound dressing is suitable; see *Planters' Bulletin 17*, page 28.

Trunk Snap

Wind pressure – The trunk snaps because it is unable to bear the stress set up by the action of the wind on the crown. The leverage exerted on the trunk will depend on the following factors: first, the force exerted by the wind as described above; second the characteristics of the tree's crown, its height, size, density and possibly obscure features such as the position of the leaves on the branches. The nature of the crown is partly genetically determined, i.e. characteristic of the clone or family, but can be modified by husbandry; the size and density of the crown can be reduced, for instance, by pollarding to promote lower branching and by thinning out of branches or increased by manuring – especially with nitrogen – which induces heavier foliage development.

The strength of the trunk – The tree may be regarded as a cylindrical beam. The *modulus of rupture* is a measure of mechanical strength determined by static bending tests on timber samples. The maximum stress which can be borne without fracture is proportional to the modulus of rupture multiplied by the cube of the radius. The Forest Research Institute (Federation of Malaya) has kindly tested samples of hevea timber. The tests are time consuming and have been limited to a preliminary comparison of timber strength in trees prone to and free from trunk snap.

On an estate near the coast there have been severe losses of RRIM 501 due to trunk snap after two or more years tapping, whereas no damage had occurred in neighbouring PR 107 of similar age and history. Three groups of trees were sampled on this estate, five trees in each sample. In addition, five trees of RRIM 501 were taken from another estate where no damage had been experienced. The mean modulus of rupture in pounds per square inch for 'green' timber samples is given for each group in the following Table.

TIMBER SAMPLES, MODULUS OF RUPTURE, LB PER SQUARE INCH

Site	Near the coast			Inland
Immature history	Generous manuring, including nitrogen, trees well grown			Rather poorly grown
Clone	PR 107	RRIM 501	RRIM 501	RRIM 501
Wind damage to stand to date	None	Severe		None
Condition of trees when sampled	Intact	Stumps of broken trees	Intact	Intact
Modulus of rupture, group mean	7,414	7,259	6,867	6,467
Ratio to PR 107	1.00	0.98	0.93	0.87

With the exception of the left hand pair, the group means for modulus of rupture are significantly different. Nevertheless the differences do not account for the very different incidences of wind damage. The RRIM 501 on the inland site, although weakest in intrinsic timber strength, has escaped damage, probably for two reasons: first lower incidence of high winds in the locality and, second, relatively poor canopy development. The wind fastness of the PR 107 stand as a whole is attributed to the greater girths of the trees compared with RRIM 501; how this has come about will be discussed below. The relatively small advantage in modulus of rupture enjoyed by the PR 107 is insignificant compared with the effect of greater girth, since the strength of the tree is proportional to the cube of the radius.

One further point should be noted from this preliminary study. The more generous manuring and vigorous growth does not appear to have caused inherently weaker timber, indeed the converse appears to be true in this limited study. The authorities on timber strength are reticent on this point, but suggest that for diffuse porous hardwoods such as hevea the maximum strength is obtained with uniform average growth; uneven or interrupted growth causes internal stresses and weakness. Rapid growth has led to low strength in some timber species. The increased incidence of wind damage often associated with heavy dressings of nitrogen is probably the result of heavy foliage development. PB 86 is rightly regarded as a wind-fast clone, but a storm caused severe damage in one instance where the normally rather light canopy had been exceptionally improved by a full manuring programme including magnesium (PB 86 often shows magnesium deficiency symptoms).

Height of trunk snap – The height at which the trunk snaps varies but is often about five feet in budded trees. It is sometimes asked why the trunk does not snap at the point of maximum leverage near the ground. First, there is the reaction to the applied force, so that the trunk (which is not inflexible) is bent and broken as a bow between the applied force and its reaction. Second, in most trees the intrinsic timber strength within the tree declines with height. This has not been investigated extensively in hevea but we have detected a 6% decline in modulus of rupture for a 20 inch difference in height of sampling. Finally the trees are thicker, and hence stronger, nearer the base. Since seedlings taper more than buddings the former are better adapted to meet the increasing leverage lower down the trunk. In practice, seedlings either snap higher on the trunk than buddings or are uprooted.

Effect of tapping on girth and trunk snap – Catastrophic losses of RRIM 501 by trunk snap are fortunately rare up to the present date. Nevertheless the incidence of damage in this clone is greater and more widespread than anticipated. The original large scale trials of this clone were planted before the war and tapping commenced after the rehabilitation period when the trees were eight or more years old. The average girth at opening exceeded 25 inches in most trials. Wind damage

was rare and RRIM was therefore regarded as wind fast; the exceptions, where some losses of RRIM 501 were sustained, occurred during severe storms after several years of tapping.

Since the war RRIM 501 has been extensively used in replantings. Virtually no wind damage has been experienced during immaturity. These replantings have been opened for tapping when the trees have attained the usually accepted tappable girth of 20 inches. Trunk snap cases have occurred after two or three years tapping.

RRIM 501 yields well from the commencement of tapping and, perhaps because of this high yield, the girth increment of trees in tapping is greatly reduced compared with immature trees or untapped trees of the same age. The increment of tapped trees in many trials is only about half an inch per annum so that the development of the trunk comes almost to a standstill. We have good reason to suppose that the crown is still increasing in size at this stage. The canopy can be seen to spread over wide avenues and some extension of the twigs always precedes the bearing of new leaf. Thus a disparity between crown and trunk develops and the tree becomes susceptible to trunk snap.

This hypothesis is not fully proven but fits most of the observations. The trees in the original trials established before the war suffered little damage, but they had girths at least 25% more at the time of opening than in current practice. This 25% advantage in girth, i.e. 25 inches versus 20 inches, means a 56% increase in area cross section and a 95% increase in the maximum stress the tree can withstand. Thus although the trees in the original trials suffered the same depression in girth increment under tapping, they were already much stronger when tapping began. Similarly, we know of RRIM 501 opened at 18 inches girth which has a higher incidence of trunk snap than RRIM 501 in the vicinity opened at 20 inches. Trunk snap has been induced to a limited extent in PB 86 by premature opening.

A parallel case is the severe incidence of trunk snap in the very high yielding RRIM 614 after two and half years of tapping in large scale trial at the R.R.I. Experiment Station. The mean annual girth increment of the tapped trees is reduced to less than an inch despite the vigorous growth of untapped trees. LCB 1320 has been grown to maturity in Malaya with few losses and it has been suggested that the wind-prone nature of this clone has been exaggerated. However, it appears that heavy losses are sustained after about four years of third daily tapping in Java. Although the girth increment of LCB 1320 may not be so reduced as in RRIM 501, the tall heavy crown of the former will aggravate the wind-susceptible condition. On the other hand clones like PR 107, which are slow starters in yield and suffer little reduction in girth increment, do not suffer trunk snap although similar in other respects to adjacent material which has become wind prone.

The hevea tree suffers from the peculiar disadvantage that exploitation reduces the girth increment of relatively young trees. The greater

Figure 2. RRIM 613. Two years old. Crowded branches arising at a narrow angle, this form of branching induces weakness.

Figure 3. Fork break. Note the bark (dark area) included in the crotch. This is the only case of wind damage of any type in RRIM 623 to date.

Figure 4. Trunk snap in Ch 26.

Figure 5. RRIM 501 in a highly wind susceptible condition. Spindly growth in wide avenues. Heavy foliage at a high level. Girth increment reduced by three years tapping. Some trunk snap cases have already exposed the crowns.

Figure 6. Trees of RRIM 613 around the edge of a wind damage patch; note the leaning away from the gap.

Figure 7. Trees leaning away from a developing gap in the canopy.

Figure 8. Fork break and trunk snap in Tjir 1; note the branching habit.

*Figure 9. Trunk snap cases of **RRIM** 501 in the path of a storm; note the distortions of the trees at the edge.*

Figure 10. Combined fork break and trunk snap in PB 86. The heavy branch (below) was torn away by wind and the weakened trunk subsequently snapped.

Figure 11. Trunk snap and uprooting of PB 86; the larger trees have been uprooted.

Figures 12 and 13. Trunk snap and uprooting in P.B.I.G. seedlings. Note that the trunk snap is usually higher on seedlings than on buddings.

Figure 14. Trunk snap in RRIM 614.

Figure 15. Extensive trunk snap in RRIM 501.

Figure 16. ICB 1320 one year after trunk snap. Damage occurred after four years S/2.d/3.67% tapping in Java. Left, leaning tree with bark bursts; right and centre, pollarded trees with regenerated foliage back in tapping.

Figures 17, 18 and 19. Old rubber around gaps. The gaps may have originated from root disease losses in the first place. The trees are distorted and lean away from the open spaces.

the exploitation the less is the increment. For instance, yield stimulation of young trees causes an almost complete standstill in girthing. As a rule, high yielding material is more depressed in girth increment than low yielding material. On third daily tapping the girth increment is better than on alternate daily tapping but only slightly so. During the first years of tapping, third daily gives 15 – 20% less yield per annum than alternate daily and the girth increment is up to 10% better, but at best this is less than 1% of the total girth; the improvement obtained by less intensive exploitation during the first years of tapping is insufficient to prevent the disparity developing between crown and trunk. Thus the only change in tapping practice likely to improve resistance to trunk snap is *postponement* until an adequate girth has been attained.

The selection of high yielding material, which yields well from the commencement of tapping, seems to bring in its train higher incidence of trunk snap if the trees are opened at the conventional standard of 20 inches girth. We must recognise this tendency which is apparently becoming more pronounced.

Uprooting

We must first dismiss wind falls which are really undiagnosed cases of termite or root disease attack. Uprooting is more common on some sites where water-logging or hard pans in the soil restrict root development and on peat soils where the anchorage is poor. If nothing can be done to improve these site conditions the only course is to use planting material with light or squat crowns, avoid large applications of manures likely to stimulate heavy foliage production and thin the canopy where appropriate. Clones with a tendency to lean should be avoided.

Uprooting may occur wherever the trees stand in the path of a severe storm. Trees susceptible to branch breakage or trunk snap will suffer such damage; trees strong enough to withstand these forms of damage may be uprooted. In localities where severe storms are frequent the general measures discussed below should be applied to maintain a closed canopy in which the individual crowns are neither too tall nor too heavy.

PREVENTATIVE MEASURES

Pruning

We have already mentioned the removal of branches forming an acute angle with the leader and the thinning of unduly dense canopies. Young trees which grow tall without branching are sometimes pollarded to induce crown development at a low level. This is recommended provided the proper procedure including after-care is followed. When pollarding use extension shears, a sharp knife on a long handle or a step ladder to reach the upper stem; do not bend the tree down because this promotes the lop-sided production of shoots along the stretched side. The leaves of hevea and hence the buds are borne in a spiral. The interval is not constant. Short intervals giving the appearance of

close whorls alternate with well spaced buds. A tree should be pollarded below a whorl of buds so that side shoots arise from the well spaced buds beneath.

The side shoots should be thinned by pruning to give a balanced crown, the branches as far spaced out as possible and evenly on all sides. As far as possible retain branches arising at a wide angle in preference to those at an acute angle. Since the upper branches tend to arise at a more acute angle than the lower, one should curb the natural inclination to remove the branches within easy reach.

There has grown up in rubber planting practice a belief that once the tree is planted, apart from pruning off side shoots arising on the potential panel or removing stock shoots from buddings, no tending of the tree itself is necessary until tapping begins. Although the trees are weeded, manured and their health cared for, their form is left to circumstance. This approach surprises fruit growers or tea planters. It seems to be a natural law that the more you expect the more you must contribute and the use of high yielding material always entails more careful husbandry. Although the plant breeder endeavours to find clones and seedling families which have as many good characteristics as possible, the multitude of desirable features makes it inevitable that at this stage there will be defects combated. These must be anticipated by constant inspection and treatment, even if it needs a revision of the planter's attitude and an intensification of his activities.

Planting System and Thinning

Crowding promotes tall spindly growth. A continuous canopy is preferred. Wide avenues and hedge systems should therefore be avoided. Thinning should be a continuous process, planned to remove unwanted trees so that an even, vigorous growth and balanced crown development are encouraged. Moreover, as far as possible the major thinning should be completed before the trees enter into a wind susceptible phase. This allows the canopy to close over the gaps.

A curious feature might be mentioned here. Where trees grow without competitors on one side, for instance the field margin by a road, the trees lean outward into the open space. However, if a gap is opened in a closed stand the trees often, but not always, lean away from the gap and become distorted. Sometimes paths of stress may be seen in the bark along which burrs and dry patches arise. This leaning backward into the stand may be caused by convection and eddy currents. The wind susceptibility of the distorted trees is increased. In wind susceptible material, therefore, a tree to be thinned should be eliminated in stages by cutting out individual branches separately so that the crown is removed without undue opening of the canopy. These unwanted trees can be intensively tapped during this period, e.g. by tapping on a full circumference cut at the same frequency as the rest of the stand.

Pollarding

If it is discovered that a stand is in a wind prone condition, a possible but expensive procedure is to pollard all trees at 14 feet and to allow crown regeneration at a low level. This is being tested currently and cannot yet be recommended as definitely worth while. If disaster is threatening drastic measures are needed; but it is preferrable to avoid the necessity.

Postponement of Tapping

In our discussion of trunk snap we have shown how susceptibility may be influenced by the girth attained before the reduction of girth increment under exploitation. At present our evidence is circumstantial; experiments are in progress to test this hypothesis. We estimate that postponement of opening until the trees have a girth of 25 inches or more, coupled with the other measures, would satisfactorily reduce the vulnerability of RRIM 501.

The criterion of tappability or attainment of adequate maturity for exploitation has been determined arbitrarily. It has been recognized that it is uneconomic to tap too soon and that a severe depression in growth follows premature tapping. The standard of 20 inches for buddings and 22 inches for seedlings has been reached as a practical compromise which has worked reasonably satisfactorily in the past.

We now find that application of this standard entails a serious risk of cutting the life of the stand short before the most productive period in certain clones and perhaps families of seedlings. This consideration warrants a revision of our views. Unfortunately changes of crop estimates and replanting cycles are involved too. These may be well worth while over the life of the stand but pose difficult immediate problems.

Delayed opening has been advocated in the past on the grounds that larger trees with a greater length of tapping cut will yield more throughout their entire tapping life. In certain trials we have opened trees of the same clones in adjacent plots but at different girths. Although flush yields attributable to the greater length of tapping cut have been obtained at first, during later life the yields of all materials settle down to a level appropriate to their age despite continuing differences in girth. The contention that delayed tapping gives a permanent increase in yield is therefore not substantiated.

In order to enhance the life of the stand the greater part of the yield over the delay period has to be sacrificed, but in any attempt to calculate loss of profit the following factors should be borne in mind. The delay period is the time of lowest yields and tapping costs will be saved; when the trees are opened the yields will be high and tapping economic. Futhermore, the exploitation of older material can often be safely intensified to recoup the losses sustained during delayed opening of the new. (See *Planters' Bulletin 38*, page 106, 'Intensive Tapping of Mature Rubber').

Manuring

Adequate manuring to promote good growth during immaturity appears to have no untoward long term effects on timber strength. It may cause clones with a tendency to top-heaviness, e.g. RRIM 603, to bend unduly if large applications are given. This temporary disadvantage may be corrected by roping and possibly prevented by branch pruning. When material is approaching a wind susceptible condition owing either to site or inherent characteristics, it is advisable to adopt a policy of reducing the size of applications and compensating by more frequent application if necessary. This is to reduce the risk of producing very heavy flushes of foliage.

TREATMENT OF WIND DAMAGED TREES

Branch Break

Where a large limb has been torn away, trim the ragged wound, apply a wound dressing, and remove any adjacent large branch liable to extend the damage, leaving the leader only.

Trunk Snap

If broken at less than six feet from the ground the tree is probably not worth saving; tap until dry. Taller stumps may be pollarded in sound tissue, wound dressing applied and canopy allowed to regenerate. A rest of six months from tapping would probably prove advantageous.

The problem is what to do with the surrounding stand which is almost certainly wind susceptible and now severely exposed. Branch thinning to lighten the crown and a rest from tapping to allow resumption of girthing may be successful eventually, but there is a serious risk of loss before this treatment can be effective. Probably pollarding the trees is both the most promising – and expensive – measure. Distorted trees immediately surrounding the opened area must in any case be pruned or pollarded.

If the damage is so extensive that replanting appears unavoidable, we would recommend an intensified exploitation of the remaining trees, e.g. by 2S/2.d/3.133% tapping (cuts four feet apart on opposite sides of the trees) until the time when they are removed.

CONCLUSION

Wind damage is proving a serious threat to high yielding rubber. Several of the most promising new selections (e.g. RRIM 613), have had to be abandoned for this reason. Conventional maintenance and exploitation induces a highly wind prone condition in some clones such as RRIM 501, which was not hitherto suspected owing to the circumstances of the original trials and the freedom from damage during immaturity. The risk seems to be greater with budded rubber but seedlings are by no means completely immune.

Investigation continues into means of preventing wind damage and of selecting wind-secure varieties; but the goal is not yet achieved. We have presented here the conclusions reached since the serious nature of the problem became apparent about a year ago. Our recommendations are tentative in part and the reader must judge our arguments. To await full confirmation of the views expressed here might involve serious delays in revision of long-term policy and deprive planters of the opportunity to judge whether the suggested measures should be put immediately into effect.

Ladder Tapping of Budded Trees: Height of Opening

WE GIVE BELOW A REPORT on an experiment, initiated and carried out by the manager of Linsum Terentang Estate, in which the yield of budded trees of clone PB 86 opened for ladder tapping at 90 inches has been compared with that of similar trees opened at 110 inches from the union. The experiment is conducted in a small field of 18.2 acres and no experimental design has been used.

TAPPING HISTORY

The field was planted in 1936 and budded in 1937. The trees were opened for tapping in November 1946 at a height of 36 inches above the union. Tapping was done alternate daily on a half circumference spiral cut (S/2.d/2.100%).

Opening of the second panel was not simultaneous for all trees but was spread over several months as the low panels were tapped out; it took place in the latter part of 1949 and the beginning of 1950, at a height of 40 inches above the union.

A third panel was opened in 1953-4, again gradually, as the old tapping panel was tapped out, at 60 inches above the union and hence 24 inches above the panel opened in 1946.

The yields showed a considerable downward trend as the cuts approached the junction between virgin and renewed bark and it was then decided to open high panels for ladder tapping. We note here that we should have preferred to open the third panel at 36 inches in renewed bark rather than at 60 inches. If the bark renewal is not satisfactory, high panels should be opened at not less than 90 inches from the union and – as shown by the results of the experiment under review – preferably as high as possible.

In August 1955, the trees in part of the field (5.2 acres) were opened at 110 inches and the trees in the rest of the field (13 acres) were opened at 90 inches from the union, above the panel opened at 40 inches in 1949 – 50.

Tapping continued on the alternate daily half spiral system and a good standard of tapping was maintained with a bark consumption of between 11 and 12 inches per year.

YIELDS

The yield records covering the period of ladder tapping are summarised in the Table.

As there are no replications of treatments it cannot be said whether the differences in yield level during the first 1 to $1\frac{1}{2}$ years of tapping are due to different heights of opening or to chance.

There is however no doubt that the downward yield trend of the trees opened at 90 inches is real and that the high yield level of trees opened at 110 inches is maintained for a longer period.

YIELD ON LADDER TAPPING OF CLONE PB 86

Mean yield of half yearly periods in lb per acre per month

Half yearly periods	*Trees opened at 110 in.*	*Trees opened at 90 in.*	
	in lb	*in lb*	*as % of trees opened at 110 in.*
Aug. '55 – Jan. '56	141	129	91.5%
Feb. '56 – July '56	105	98	93.3%
Aug. '56 – Jan. '57	127	109	85.8%
Feb. '57 – July '57	132	95	72.0%
Aug. '57 – Jan. '58	139	103	74.1%
Feb. '58 – July '58	131	83	63.4%
Aug. '58 – Jan. '59	145	79	54.5%

CONCLUSIONS

The conclusion from this experiment is that in mature fields of budded trees scheduled for ladder tapping, cuts should be opened as high as possible.

It appears that a bark consumption of 12 inches per year is possible when tapping high panels.

We recommend the use of a stimulant at the time when the downward yield trend sets in as a result of the cut approaching the junction of virgin and renewed bark.

Checking the Spread of Root Disease

A RUBBER TREE BECOMES INFECTED with root disease only when its roots have made contact with the fungus growing out of woody material in the soil. Direct infection is brought about by the spread of the fungus in its vegetative phase. Although the three major root diseases—*Fomes lignosus, Ganoderma pseudoferreum* and *Fomes noxius*—freely produce fruit bodies which liberate spores in abundance, spore infection of an intact and healthy tree does not take place.

COLONISATION OF STUMPS BY SPORES

This is not to say that the spores are without function. They are able to colonise dead and moribund wood. Of greatest significance is their ability to colonise the stumps of felled trees, creating new sources of infection from which the disease will slowly spread if left unchecked. This aspect of root disease control was stressed in the article 'Root Disease and Replanting' in *Planters' Bulletin 35*. At that time we knew that applying creosote to the cut surface of newly felled stumps, without poisoning them, had some effect in reducing the number which later became sources of infection of the young stand. We did not know whether the surface treatment would have any effect when applied to stumps which were being poisoned to hasten their decay — as is most necessary. Since then we have observed the effect of creosoting the cut surface of poisoned stumps in two locations. The results, though not complete, can now be assessed.

SURFACE TREATMENT OF POISONED STUMPS

The first site is on our Experiment Station, where additional surface treatment was applied to alternate rows of stumps in a contour-planted field on a hillside where the soil is a sandy loam. Root disease in the replanting has occurred largely within a ten acre area in the lower part of the field. The numbers of stumps found to be sources of infection of the young stand are: 16 of the creosoted and poisoned stumps; 31 of the stumps which, though poisoned, received no treatment on their cut surfaces.

The second site is on coastal alluvial clay, where the creosote treatment was alternated with no surface treatment in ninety-six plots occupying forty-eight acres. Here the results are similar. Of the surface-treated stumps, 48 became sources of infection; for the stumps given no surface treatment, the figure was 104. Statistical analysis has shown the difference to be highly significant.

RECOMMENDED STUMP TREATMENT

In a replanting, small sections of root found to be sources of infection can easily be dug out and burned. More troublesome are the stumps of the old trees; being large, they are difficult to remove, and they take longer to decay. A simple treatment which reduces by half the number

of stumps which become sources of infection is therefore of the greatest interest. The cost of applying creosote is only about two cents for labour and up to eight cents for the material to treat a large stump. We would therefore now advise that this treatment be applied wherever trees are being felled — for replanting, for thinning a young stand, or when a tree has to be cut out of a mature stand for any reason. The stump should then be poisoned in the usual way with either sodium arsenite or 2,4,5-T. Though we do not yet know how quickly spore colonisation takes place, clearly it is a wise precaution to put the creosote on at the earliest moment, that is, immediately the tree is felled.

LIMITED ROLE OF FUNGICIDES IN TREE TREATMENT

We are sometimes asked whether the spread of root disease can be checked by applying a fungicide to the soil. Investigations along these lines were started three years ago, based on field observations suggesting that the rate of spread of the disease depends on the rate of growth of the external rhizomorph. Later, inoculation experiments with *F. lignosus*, described in a paper in our *Journal* volume 15, part 4, showed that extension of the fungus within a root could be halted by preventing its growth on the root surface. It is apparent, therefore, that a treatment which made the soil in the region of the collar fungicidal or fungistatic would be a most valuable defence, protecting the tree where it is most vulnerable to attack, and greatly hindering the spread of the disease from tree to tree. Though a soil drench is most successful in protecting the same part of the tree against termites — a paper in the same issue of our *Journal* shows that certain insecticides remain active in the soil for long periods when used at dosages which are cheap and easy to apply — we have not found these exacting requirements to be met by any currently available fungicide.

Fungicides have a limited use in the control of root disease, as an adjunct to excision of infected wood and removal or isolation of sources of infection. These procedures are described in detail on page 38 of the *Planters' Bulletin* article to which reference has already been made.

Boric Acid for the Preservation of Low Ammonia Latex Concentrate

Recently we have tested samples of technical grade boric acid obtained from Borax Consolidated Ltd, who are the main suppliers of boron compounds, through the agency of I.C.I. (Malaya) Ltd. Up to the present time, boric acid BP grade has been recommended for preservation of low ammonia boric acid latex concentrate. We now find that cheaper technical grades of boric acid are satisfactory. These technical grades can be in either powder or granular form and there is no difference between the two forms in respect of speed of solution.

Supplies of boric acid obtained by producers up to the present have been in kegs; technical grades are also available in burlap sacks which would give an additional saving. Thus by using technical grades in burlap sacks a maximum reduction in cost of 0.3 cents per gallon of concentrate can be expected. Should latex producers obtain their supplies from a source other than the above we will be pleased to test a sample if desired.

Production of low ammonia boric acid latex concentrate has increased considerably during the past year and up to the present date over 1,000,000 gallons have been shipped from Malaya.

The preservation of latex with boric acid is subject to a patent Application No. 32612/55 by the R.R.I. and permission to use the process must be obtained from the Board of the Rubber Research Institute of Malaya.

Mouldy Rot Fungicides

An article in *Planters' Bulletin 25*, issued in July 1956, includes a list of approved fungicides. There have since been four additions. Sanitas Okol, a tar acid preparation effective at a concentration of 30%, has already been noted on page 45 of *Planters' Bulletin 35*. The other three, with their local agents, are: Brunosil — James Warren and Company Limited; Seprisan — Rotterdam Trading Company (Malaya) Limited; Antimucin WBR — Malayan Fertilisers Limited. We recommend that they be employed at a concentration of 0.25%, but the strength of the last two named can be increased to 0.5% in difficult cases. Higher concentrations cannot be used without the danger of burning newly tapped bark.

Rhizobium Compost Culture

The demand for Rhizobium culture, introduced in compost form in September 1956, is now about 12,000 packets a year. It follows that each year some 50,000 acres are planted with inoculated seed — approaching half the annual acreage planted or replanted. Most of the culture supplied was of the strain developed for *Centrosema pubescens*, *Pueraria phaseoloides*, and *Calopogonium mucunoides*, and was used for inoculating one, or a mixture, of these three species. The same culture can be used for *Crotalaria usaramoensis*, *Crotalaria striata*, and *Desmodium ovalifolium*.

Another strain of culture must be employed for inoculating *Flemingia congesta;* this can now be supplied as a compost from stock. Several other special strains are available, but we need a fortnight's notice to prepare them as a compost. One of them will form nodules on both *Crotalaria anagyroides* and *Tephrosia vogelii*, another on *Clitoria rubiginosa*, and a third on *Mimosa invisa*. A culture for *Stylosanthes gracilis* has been made, but it has not yet been possible to prove its effectiveness.

Maladies of Hevea

Maladies of Hevea in Malaya by Roger N. Hilton, with 41 coloured illustrations by Hoh Choo Chuan, is now available for distribution. It is priced at $30(Malayan) but is available at $20 in the Federation of Malaya, Singapore, Brunei, North Borneo, Sarawak and Nigeria.

Prepared primarily as a recognition manual for planters,

this book covers the diseases, injuries and disorders of the rubber plant.

Nutritional disorders are not given detailed treatment: they have already been described and illustrated in Communication 300 of our *Journal*, Volume 14, 1956. Copies of Communication 300, entitled 'Visual symptoms of mineral deficiencies of *Hevea brasiliensis*' are still available, price $2(Malayan).

Good Tapping

A revised edition of *Good Tapping*, first published in 1957, is now available in English and Jawi, price 50 cents. It is published by the Smallholders' Advisory Service of the R.R.I.

Correspondence

The Editor invites letters of general interest for publication in this column. Comment and queries from articles recently published will be welcome.

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TAPIOCA AS A WEED

'We would be obliged if you could recommend to us a spray to kill *ubi kayu* (tapioca), a weed of rubber plantations here'.

The Manager
North Borneo Rubber Ltd
Melalap Estate
via Jesselton
B.N. Borneo

We would expect a hormone type of weedkiller to be effective and suggest Fernoxone for trial on a small scale in the first instance. Fernoxone is a formulation of the sodium salt of 2,4-D and application at the rate of 1 lb to 20 gallons of water seems likely to be effective.

Should Fernoxone prove ineffective or give inadequate control we suggest trying Floroxone, a liquid formulation containing esters of both 2,4-D and 2,4,5-T, at the rate of 1 pint to 25 gallons of water. The effectiveness of both materials will be increased by adding one of the wetting agents, e.g. Teepol, Lissapol N or Comprox A to the spray at the rate of 1 oz to 25 gallons. With both materials it is very important not to allow any spray drift to reach young rubber plants.—Editor

Controller of Research

Sir Geoffrey Clay, K.C.M.G., O.B.E., M.C., assumed duty in April as Controller of Research and Chairman of the reconstituted Malayan Rubber Fund Board.

Sir Geoffrey is an agricultural graduate of Edinburgh University and he also took the National Diplomas in Agriculture and Dairying and did post-graduate studies at Cambridge University. He served with distinction for over 20 years in the Colonial Agricultural Service in East and West Africa, and became Agricultural Adviser to the Secretary of State for the Colonies, 1946-1956.

Sir Geoffrey visited Malaya in 1948 in connection with proposals for a Regional Agricultural Research Organisation, and recently held a post with the Food and Agricultural Organisation of the United Nations in Rome.

As Controller of Research for Natural Rubber, Sir Geoffrey will be intimately concerned with the future planning and development of the work of the Institute.

R.R.I. Lectures Available to Planters' Societies

When requesting a lecture, please name alternative titles and give the Director adequate notice of your requirement.

Soils Division

Observations on manuring of rubber based on results of field experiments
Current thoughts on ground covers in rubber areas
Recognition of nutrient deficiency symptoms shown by rubber and legume covers (evening lecture)
The absorption and translocation of nutrients by plants (evening lecture)
The use of herbicides for weed control

Botanical Division

Breeding and selection of RRIM clones
Planting material in practice
Tapping and stimulation of yield
Factors influencing the performance of hevea

Pathological Division

Root disease control and the role of fungicides
Diseases and injuries of the stem and branches (evening lecture)
Recognition of pests (evening lecture)

Chemical Division

Superior processing rubber
Latex concentrate production
General processing of plantation rubber
Synthetic rubber
Technical liaison between producer and consumer

Statistics

The statistical background to field experimentation
The choice of an appropriate statistical design for field trials

Advisory

The Estates Advisory Service and its work on field problems

OUR COVER SHOWS TRUNK SNAP OF RRIM 501 BUDDINGS IN THE PATH OF A STORM.

Photo P.R.W.

The Standard Engravers & Art Printers, 63 Campbell Road, Kuala Lumpur, Selangor